Hexark and Preon Model #7: for Standard Model elementary particles, Higgs, Gravitons, Dark Energy and Dark Matter

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Abstract

This paper shows a model for building all elementary particles of the Standard Model plus the higgs, dark matter and gravitons, out of preons and sub-preons. The preons are built from string-like hexarks each with chiral values for the fundamental properties of elementary particles. Hexark colour and tone completely determine particle colour charge and electric charge. Gravitons occur in three generations: the first generation graviton is colourless and gives rise to dark energy. The third generation gravitons are coloured with colour-anticolour, like the gluon, and give rise to a generally attractive but very weak force over an inter-galactic range, just as the gluon gives a generally attractive but much stronger force over a much shorter distance. The third generation higgs, recently discovered, also has colour-anticolour. Model #7 replaces the old Model #6 of May 2015 which did not cater for the graviton.

Hexarks

It is assumed here that the smallest parts for particle building are hexarks. Quarks make the fourth order layer, preons the fifth order and hexarks the sixth order. Particles have the following fundamental properties: chirality (left- or right-handedness), electric charge, spin, weak isospin, colour charge, matter/antimatter and mass. The hexarks need to be constructed with respect to these properties.

These eight properties in terms of hexarks are chirality (L or R handedness) in spacetime, matter or antimatter (antimatter denoted by ‘), electric charges (+ or -), spin (+ or -) and weak isospin (+ or -), three hexacolour/antihexacolour charges (red, green, blue, antired, antigreen and antiblue). Mass is assumed here to be an emergent property and not fundamental. The metric of space and time is also deemed to be an emergent property which also is not necessary to be modelled by its own fundamental quality within preon structures.

In this model, it is not necessary to include electric charge for hexarks as there is a correspondence between a particle’s electric charge and its net hexark/preon hexacolour. If the three hexacolours are each designated as having white hexatone and the antihexacolours as having black hexatone, then negative electric charge corresponds to a predominance of

white hexatone and positive electrical charge corresponds to a predominance of black hexatone. This correspondence does not apply for elementary particle colours as the red up and red down quarks have electric charges with opposite signs. The hexacolour charges for up and down quarks are predominantly black and white in hexatone, respectively, with amounts corresponding exactly to their electric charges. Despite the replacement of electric charge by hexatone in the fundamental properties, electric charge is much too familiar a term to be left out of the description of the hexark structures. The use of 'tone' is borrowed from art colour theory and the amount of electric charge of a particle depends exactly on its hexatone, that is, depends on the excess of colour over anticolour, or vice versa, the particle contains.

The negative electric charge is, furthermore, connected only to left-handed hexarks, L, and anti-right-handed antihexarks, R'. Right-handed hexarks, R, and anti-left-handed antihexarks, L', will have only positive electric charges. Hexacolour charges are therefore embodied entirely within the L and R' hexarks while antihexacolour charges are embodied entirely within the R and L' hexarks. Every hexark has spin of either + or - and has weak isospin of either + or -. The total number of hexarks in the model is 48. There are 24 matter hexarks (L and R) and a corresponding 24 antimatter antihexarks (denoted L' and R'). Hexarks can be labelled as: (Hexark handedness and matter/antimatter) (electric charge) (spin) (weak isospin) (hexacolour charge) for example, R' - + - r, and are shown in Tables 1a and 1b.

Table 1a: Chiral structures of the 24 hexarks

L - - - r	L - - + r	L - + - r	L - + + r
L - - - g	L - - + g	L - + - g	L - + + g
L - - - b	L - - + b	L - + - b	L - + + b
R + - - r'	R + - + r'	R + + - r'	R + + + r'
R + - - g'	R + - + g'	R + + - g'	R + + + g'
R + - - b'	R + - + b'	R + + - b'	R + + + b'

Table 1b: Chiral structures of the 24 antihexarks

L' + + + r'	L' + + - r'	L' + - + r'	L' + - - r'
L' + + + g'	L' + + - g'	L' + - + g'	L' + - - g'
L' + + + b'	L' + + - b'	L' + - + b'	L' + - - b'
R' - + + r	R' - + - r	R' - - + r	R' - - - r
R' - + + g	R' - + - g	R' - - + g	R' - - - g
R' - + + b	R' - + - b	R' - - + b	R' - - - b

A hexark's electric charge is + or - 1/48; A hexark's spin is + or - 1/48; A hexark's weak isospin is + or - 1/48. A hexark's hexatone is also + or - 1/48.

Preons and sub-preons

Preons and sub-preons are made of aggregates of hexarks, unlike in the Rishon preon model (Harari, 1979, and Shupe, 1979) which does not use hexarks. In Model #7 there are four preons: A, B, C and E, which have antimatter versions: A', B', C' and E'. Preon C has no spin or weak isospin and is divisible into three colour sub-preons: Cr, Cg and Cb with "antimatter" versions C'r', C'g' and C'b'. The hexark content of each preon and sub-preon is given in the Appendix. Each preon contains twelve hexarks and twelve antihexarks. Properties of the preons and sub-preons are shown in Table 2.

Table 2: The four preons and three hexacoloured sub-preons

Preon	Number of hexarks	Electric charge	Spin	Weak isospin	Hexatone
A	24	-1/2	-1/2	-1/2	White (-0.5)
B	24	-1/2	+1/2	0	White (-0.5)
C	24	-1/2	0	0	White (-0.5)
E	24	-1/2	+1/2	-1/2	White (-0.5)
A'	24	+1/2	+1/2	+1/2	Black (0.5)
B'	24	+1/2	-1/2	0	Black (0.5)
C'	24	+1/2	0	0	Black (0.5)
E'	24	+1/2	-1/2	+1/2	Black (0.5)
Sub-preon					Hexacolour (and hexatone)
Cr	8	-1/6	0	0	Red (-1/6)
Cg	8	-1/6	0	0	Green (-1/6)
Cb	8	-1/6	0	0	Blue (-1/6)
C'r'	8	+1/6	0	0	Antired (1/6)
C'g'	8	+1/6	0	0	Antigreen (1/6)
C'b'	8	+1/6	0	0	Antiblue (1/6)

The whiteness or blackness of the preons does not affect elementary particle colours but does affect the elementary particle electric charge. Therefore a, say, hexared preon must have a negative electric charge but a red quark could have a negative or positive electric charge depending on the net whiteness or blackness, that is the net hexatone, of its preons and sub-preons. Every preon is composed of twelve matter hexarks and twelve antihexarks. Every sub-preon is composed of four hexarks and four antihexarks.

Revision of the preon model from Model #6 to Model #7

Model #7 has seen the replacement of the Preon D of Model #6 by a new preon, Preon E. Model #6 catered for the Standard Model particles and some others but the first generation graviton could not be formed out of model #6 using only four preons so an amendment to the model was required.

Preons A, B and C were, in very early preon models, chosen to be approximately 'half' particles for the first generation electron, photon and down quarks. Later models doubled the number of preons per first generation particle to four preons, which means Preons A, B and C are now each one-quarter of a first generation particle. So Preon A is approximately a 'half' of a left-handed electron and Preon B is approximately 'half' of a right-handed electron. Preon C is 'half' of a particle but with net zero spin and weak isospin which was a requirement to allow quarks to be built using the sub-preons Cr, Cg and Cb which each has electric charge = -1/6. In model #5, the characteristics of the left-handed up quark and the neutrino were incorrectly modelled and that required a new Preon, Preon D, which was sufficient to complete the task of modelling all the Standard Model particles. Preons A, B, C and D of Model #6 were not, however, sufficient to build the first generation graviton. The paper by Hue and Ninh (October 2015) predicted half electrons with electric charge -0.5 and other leptons with charge -1/6. These characteristics are also those of preons A to C and sub-preons Cr, Cg and Cb, respectively, and spurred a revision of Preon D to be more like 'half' of a left-handed up quark and left-handed neutrino, and so the new Preon E was introduced into Model #7 to replace Preon D. (Preon D had electric charge -0.5, spin 0 and weak isospin 0.5, whereas Preon E has electric charge -0.5, spin 0.5 and weak isospin -0.5 which are the same spin and weak isospin as the left-handed up quark and the left-handed neutrino.) All the preons in Model #7 therefore have a theme of each being 'half' of a first generation elementary particle.

Aggregates of preons

Elementary particles are comprised, in this model, of various numbers of preons depending on whether a particle is fermion or boson and depending on the particle generation. The higher the generation, the more preons are included. The numbers of preons per elementary particle are listed in Table 4.

Table 4: Numbers of preons per elementary particle

Generation	1	2	2	3*	3**
Number of preons per particle	4	8	12	16	20
Quarks:	down		strange		bottom
	up		charm		top
Electrons	electron		muon		tau
Neutrinos	electron neutrino		muon neutrino		tau neutrino
Force bosons	Photon	Z		gluon	
Weak boson	½ W ?	W		2W ?	
Higgs	¼ higgs	½ higgs		higgs	
Gravitons	¼ G	½ G		G	
Dark matter	¼ dark	½ dark		dark	

** All bosons in this column have colour-anticolour.*
*** All fermions in this column may possibly have colour-anticolour (plus colour for the quarks).*

Although the numbers of preons in Table 4 are stated without explanation, they were derived based on likely numbers of preons per particle with respect to particle interactions in which the preons going into an interaction need to balance exactly the preons coming out of the interactions: complicated by the presence of preons coming from the vacuum or being annihilated into the vacuum at an interaction. This requires that vacuum energy be modelled by vacuum particles/fields containing preons. For example, AA'BB' could be a completely neutral vacuum particle/field.

There are three hexacoloured sub-preons and combinations of them can arise. Table 5 shows how to find the quark colour for any combination of the three different sub-preons.

Table 5: How to find a quark colour from the hexacolours of its sub-preons

First sub-preon hexacolour	Second sub-preon hexacolour	Third sub-preon hexacolour	Quark colour
r	g	b’	antiblue
r	g’	b	antigreen
r	g’	b’	red
r’	g	b	antired
r’	g	b’	green
r’	g’	b	blue

Two hexacolours when aggregated form the anticolour of the third hexacolour. For example, r + g makes antiblue; so r + g + b’ = (r + g) + b’ = (antiblue) + antiblue = antiblue.

Table 6 shows that the up and down quark electric charges are determined by the greyness, or hexatone, of the hexacolours of the preons and sub-preons of which the quarks are composed. For brevity, only the left-handed forms of the quarks are displayed in the table but the right-handed forms also conform to this pattern.

Table 6: Up and down quark electric charge, quark colour and net preon greyness

Preon and sub-preons in quarks	Electric charge	Preon hexatone	Particle colour	Quark name
B’ C C C’r’ Cg Cb	-2/3	1/2 -1/2 -1/2 +1/6 -1/6 -1/6 = -2/3	r'	LH antiup
B’ C C Cr C’g’ Cb	-2/3	1/2 -1/2 -1/2 -1/6 +1/6 -1/6 = -2/3	g'	LH antiup
B’ C C Cr Cg C’b’	-2/3	1/2 -1/2 -1/2 -1/6 -1/6 +1/6 = -2/3	b'	LH antiup
A C'g' Cr C'b' x^1	-1/3	-1/2 +1/6 -1/6 +1/6 = -1/3	r	LH down
A Cg C'r' C'b' x^1	-1/3	-1/2 -1/6 +1/6 +1/6 = -1/3	g	LH down
A C'g' C'r' Cb x^1	-1/3	-1/2 +1/6 +1/6 -1/6 = -1/3	b	LH down
B' Cg Cb C'r' x^1	1/3	1/2 -1/6 -1/6 +1/6 = 1/3	r'	LH antidown
B' C'g' Cb Cr x^1	1/3	1/2 +1/6 -1/6 -1/6 = 1/3	g'	LH antidown
B' Cg C'b' Cr x^1	1/3	1/2 -1/6 +1/6 -1/6 = 1/3	b'	LH antidown
E’ Cr C’g’ C’b’ X	2/3	1/2 -1/6 +1/6 +1/6 = 2/3	r	LH up
E’ C’r’ Cg C’b’ X	2/3	1/2 +1/6 -1/6 +1/6 = 2/3	g	LH up
E’ C’r’ C’g’ Cb X	2/3	1/2 +1/6 +1/6 -1/6 = 2/3	b	LH up

x^1 is a completely neutral component made up of either AA’, BB’ or CC’ or EE’ preon pairs, and is ignored in the calculations of hexatone or greyness.
A preon has a hexatone of + or - ½ while a sub-preon has a hexatone of + or - 1/6.
LH=left-handed RH = right-handed

Using the LH antiup antired quark from Table 6 as an example. Table 4 lists the up and down quarks as having four preons. The three sub-preons in the quark count as one whole preon in terms of numbers of hexarks contained. Table 5 can be used to find the quark colour r’ corresponding to three sub-preon hexacolours: g, b and r’. The three sub-preon hexacolours are then written as hexatone values: g + b + r’ = -1/6 -1/6 +1/6 = -1/6. The B’, C and C are also present in this quark and their hexatones are 0.5, -0.5 and -0.5 respectively, giving an

overall total hexatone of -2/3. The quark electric charge corresponds exactly to the preon hexatone for each quark form.

Hexark properties of electric charge (hexatone), spin and weak isospin are additive when calculating those properties of the preons and elementary particles. Every preon and every sub-preon contains as many matter hexarks as anti-matter hexarks.

Elementary particles as combinations of preons and sub-preons

Tables 7 to 14 show combinations of preons and sub-preons forming all the Standard Model particles, the higgs, gravitons and dark bosons.

The four-unit combinations are the smallest combinations which allow for the photon and higgs particles and the four-unit block is taken here as the smallest form of any elementary particle. For example a left-handed electron could be ACAA' or ACBB' or ACCC' or ACEE' where AA', BB', CC' and EE' act as neutral bulk fillers. This means that not every electron is identical and could imply that not every electron is equally likely to be able to participate in an interaction.

Neutral pairs of preon and antipreon are also important to the preon model as they form neutral building blocks which are the only difference between similar particles in different generations, for example electron and muon.

Table 7: Four preons (electron, photon, neutrino, ¼ higgs and ¼ graviton)

Preon units	Electric charge	Spin	Weak isospin	Particle name
ACx^1	-1	-0.5	-0.5	LH electron
BCx^1	-1	0.5	0	RH electron
$A'C'x^1$	1	0.5	0.5	RH positron
$B'C'x^1$	1	-0.5	0	LH positron
$CE'x^1$	0	-0.5	+0.5	LH neutrino
$BC'x^1$	0	0.5	0	RH sterile neutrino
$C'Ex^1$	0	0.5	-0.5	RH antineutrino
$B'Cx^1$	0	-0.5	0	LH sterile antineutrino
$B'B'CC$ or $AE'x^1$	0	-1	0	Photon
$BBC'C'$ or $A'Ex^1$	0	1	0	Photon
non-Standard Model				
x^2	0	0	0	Neutral (dark) boson
$ABC'C'$ or $B'Ex^1$	0	0	-0.5	Higgs-like particle (1/4 higgs)

A'B'CC or BE'x^1	0	0	+0.5	Higgs-like particle (1/4 higgs)
AAB'E'	0	-2	-0.5	¼G- (graviton)
A'A'BE	0	2	0.5	¼G+ (graviton)

where x^1=any one of four pairs: AA' or BB' or CC' or EE'
and where x^2= any two pairs from AA' or BB' or CC' or E', for example AA'AA' or AA'EE'

The higher generations of particles use the above basic forms of the first generation with the addition of neutral pairs of preon units. Quark forms are given in Tables 12 to 14.

Table 8: Eight preons (Z, W, ½ higgs and ½ graviton)

Preons	Electric charge	Spin	Weak isospin	Particle name
AAx^3	-1	-1	-1	LH W-
A'A'x^3	1	1	1	RH W+
BBx^3	-1	1	0	RH W-
B'B'x^3	1	-1	0	LH W+
B'B'CCx^2 or AE'x^3	0	-1	0	Z
BBC'C'x^2 or A'Ex^3	0	1	0	Z
non-Standard Model				
x^4	0	0	0	neutral (dark) boson
ABC'C'x^2 or B'Ex^3	0	0	-0.5	Higgs-like particle (1/2 higgs)
A'B'CCx^2 or BE'x^3	0	0	0.5	Higgs-like particle (1/2 higgs)
AB'B'B'CCx or AAB'E'x^2	0	-2	-0.5	1/2G- (graviton)
A'BBBC'C'x or A'A'BEx^2	0	2	0.5	1/2G+ (graviton)
B'B'B'CCCCE'	0	-2	0.5	1/2G_2- (graviton)
BBBC'C'C'C'E	0	2	-0.5	1/2G_2+ (graviton)

where x^2 = any two pairs of preons from AA' or BB' or CC' or EE', for example AA'AA' or AA'BB' or BB'EE'
where x^3 = any three pairs of preons from AA' or BB' or CC' or EE', for example AA'AA'BB' or AA'BB'CC'
where x^4 = any four pairs of preons from AA' or BB' or CC' or EE', for example AA'EE'BB'CC'

Table 9: Twelve preons (muon and muon neutrino)

Preons	Electric charge	Spin	Weak isospin	Particle name
ACx^5	-1	-0.5	-0.5	LH muon-
BCx^5	-1	0.5	0	RH muon-
$CE'x^5$	0	-0.5	0.5	LH muon neutrino
$B'Cx^5$	0	-0.5	0	LH sterile muon antineutrino
$BC'x^5$	0	0.5	0	RH sterile muon neutrino
$C'Ex^5$	0	0.5	-0.5	RH muon antineutrino
$B'C'x^5$	1	-0.5	0	LH muon+
$A'C'x^5$	1	0.5	0.5	RH muon+
non-Standard Model				
x^6	0	0	0	Neural (dark) boson
$ABC'C'\ x^4$ or $B'Ex^5$	0	0	-0.5	Higgs-like particle (3/4 higgs)
$A'B'CC\ x^4$ or $BE'x^5$	0	0	+0.5	Higgs-like particle (3/4 higgs)

where x^n = any n pairs of preons from AA' or BB' or CC' or EE'

Table 10: Sixteen preons (gluon, Higgs, dark and gravitons)

Preons[1, 2, 3]	Electric charge	Spin	Weak isospin	Particle name
$B'B'CC\ x^5$ C'g' Cr C'b' Cg C'r' Cb	0	-1	0	gluon (rr')
$BBC'C'\ x^5$ C'g' Cr C'b' Cg C'r' Cb	0	1	0	gluon (rr')
$B'B'CC\ x^5$ Cg C'r' C'b' C'g' Cr Cb	0	-1	0	gluon (gg')
$BBC'C'\ x^5$ Cg C'r' C'b' C'g' Cr Cb	0	1	0	gluon (gg')
$B'B'CC\ x^5$ C'g' C'r' Cb Cg Cr C'b'	0	-1	0	gluon (bb')
$BBC'C'\ x^5$ C'g' C'r' Cb Cg Cr C'b'	0	1	0	gluon (bb')
$B'B'CC\ x^5$ C'g' Cr C'b' C'g' Cr Cb	0	-1	0	gluon (rg')
$BBC'C'\ x^5$ C'g' Cr C'b' C'g' Cr Cb	0	1	0	gluon (rg')
$B'B'CC\ x^5$ C'g' Cr C'b' Cg Cr C'b'	0	-1	0	gluon (rb')
$BBC'C'\ x^5$ C'g' Cr C'b' Cg Cr C'b'	0	1	0	gluon (rb')
$B'B'CC\ x^5$ Cg C'r' C'b' Cg Cr C'b'	0	-1	0	gluon (gb')
$BBC'C'\ x^5$ Cg C'r' C'b' Cg Cr C'b'	0	1	0	gluon (gb')
$B'B'CC\ x^5$ Cg C'r' Cb Cg C'r' C'b'	0	-1	0	gluon (r'g)
$BBC'C'\ x^5$ Cg C'r' Cb Cg C'r' C'b'	0	1	0	gluon (r'g)
$B'B'CC\ x^5$ Cg C'r' Cb C'g' C'r' Cb	0	-1	0	gluon (r'b)
$BBC'C'\ x^5$ Cg C'r' Cb C'g' C'r' Cb	0	1	0	gluon (r'b)
$B'B'CC\ x^5$ C'g' Cr Cb C'g' C'r' Cb	0	-1	0	gluon (g'b)
$BBC'C'\ x^5$ C'g' Cr Cb C'g' C'r' Cb	0	1	0	gluon (g'b)

non-Standard Model

ABC’C’x^5 C'g' Cr C'b' Cg C’r’ Cb	0	0	-0.5	Higgs (rr’)
A’B’CCx^5 C'g' Cr C'b' Cg C’r’ Cb	0	0	0.5	Higgs (rr’)
ABC’C’x^5 Cg C’r’ C'b' C’g’ Cr Cb	0	0	-0.5	Higgs (gg’)
A’B’CCx^5 Cg C’r’ C'b' C’g’ Cr Cb	0	0	0.5	Higgs (gg’)
ABC’C’x^5 C’g' C’r’ Cb Cg Cr C’b’	0	0	-0.5	Higgs (bb’)
A’B’CCx^5 C'g' C’r’ Cb Cg Cr C’b’	0	0	0.5	Higgs (bb’)
ABC’C’x^5 C'g' Cr C'b' C’g’ Cr Cb	0	0	-0.5	Higgs (rg’)
A’B’CCx^5 C'g' Cr C'b' C’g’ Cr Cb	0	0	0.5	Higgs (rg’)
ABC’C’x^5 C'g' Cr C'b' Cg Cr C’b’	0	0	-0.5	Higgs (rb’)
A’B’CCx^5 C'g' Cr C'b' Cg Cr C’b’	0	0	0.5	Higgs (rb’)
ABC’C’x^5 Cg C’r’ C'b' Cg Cr C’b’	0	0	-0.5	Higgs (gb’)
A’B’CCx^5 Cg C’r’ C'b' Cg Cr C’b’	0	0	0.5	Higgs (gb’)
ABC’C’x^5 Cg C’r’ Cb Cg C’r’ C’b’	0	0	-0.5	Higgs (r’g)
A’B’CCx^5 Cg C’r’ Cb Cg C’r’ C’b’	0	0	0.5	Higgs (r’g)
ABC’C’x^5 Cg C’r’ Cb C’g’ C’r’ Cb	0	0	-0.5	Higgs (r’b)
A’B’CCx^5 Cg C’r’ Cb C’g’ C’r’ Cb	0	0	0.5	Higgs (r’b)
ABC’C’x^5 C'g' Cr Cb C’g’ C’r’ Cb	0	0	-0.5	Higgs (g’b)
A’B’CCx^5 C'g' Cr Cb C’g' C’r’ Cb	0	0	0.5	Higgs (g’b)
‘Darkons’ (dark bosons):				
x^7 C'g' Cr C'b' Cg C’r’ Cb	0	0	0	Dark (rr’)
x^7 Cg C’r’ C'b' C’g’ Cr Cb	0	0	0	Dark (gg’)
x^7 C’g’ C’r’ Cb Cg Cr C’b’	0	0	0	Dark (bb’)
x^7 C'g' Cr C'b' C’g’ Cr Cb	0	0	0	Dark (rg’)
x^7 C'g' Cr C'b' Cg Cr C’b’	0	0	0	Dark (rb’)
x^7 Cg C’r’ C'b' Cg Cr C’b’	0	0	0	Dark (gb’)
x^7 Cg C’r’ Cb Cg C’r’ C’b’	0	0	0	Dark (r’g)
x^7 Cg C’r’ Cb C’g’ C’r’ Cb	0	0	0	Dark (r’b)
x^7 C’g’ Cr Cb C’g’ C’r’ Cb	0	0	0	Dark (g’b)
G Gravitons:				
B'B'CC AB’x^4 C'g' Cr C'b' Cg C’r’ Cb	0	-2	-0.5	G (rr’)
BBC’C’ A’Bx^4 C'g' Cr C'b' Cg C’r’ Cb	0	2	0.5	G (rr’)
B'B'CC AB’x^4 Cg C’r’ C'b' C’g’ Cr Cb	0	-2	-0.5	G (gg’)
BBC’C’ A’Bx^4 Cg C’r’ C'b' C’g’ Cr Cb	0	2	0.5	G (gg’)
B'B'CC AB’x^4 C’g’ C’r’ Cb Cg Cr C’b’	0	-2	-0.5	G (bb’)
BBC’C’ A’Bx^4 C’g’ C’r’ Cb Cg Cr C’b’	0	2	0.5	G (bb’)
B'B'CC AB’x^4 C'g' Cr C'b' C’g’ Cr Cb	0	-2	-0.5	G (rg’)
BBC’C’ A’Bx^4 C'g' Cr C'b' C’g’ Cr Cb	0	2	0.5	G (rg’)
B'B'CC AB’x^4 C'g' Cr C'b' Cg Cr C’b’	0	-2	-0.5	G (rb’)
BBC’C’ A’Bx^4 C'g' Cr C'b' Cg Cr C’b’	0	2	0.5	G (rb’)
B'B'CC AB’x^4 Cg C’r’ C'b' Cg Cr C’b’	0	-2	-0.5	G (gb’)
BBC’C’ A’Bx^4 Cg C’r’ C'b' Cg Cr C’b’	0	2	0.5	G (gb’)
B'B'CC AB’x^4 Cg C’r’ Cb Cg C’r’ C’b’	0	-2	-0.5	G (r’g)
BBC’C’ A’Bx^4 Cg C’r’ Cb Cg C’r’ C’b’	0	2	0.5	G (r’g)
B'B'CC AB’x^4 Cg C’r’ Cb C’g’ C’r’ Cb	0	-2	-0.5	G (r’b)

BBC'C' A'Bx^4 Cg C'r' Cb C'g' C'r' Cb	0	2	0.5	G (r'b)
B'B'CC AB'x^4 C'g' Cr Cb C'g' C'r' Cb	0	-2	-0.5	G (g'b)
BBC'C' A'Bx^4 C'g' Cr Cb C'g' C'r' Cb	0	2	0.5	G (g'b)

G_2 Gravitons:

B'B'B'CCCCE'x^3 C'g' Cr C'b' Cg C'r' Cb	0	-2	0.5	G_2 (rr')
BBBC'C'C'C'Ex^3 C'g' Cr C'b' Cg C'r' Cb	0	2	-0.5	G_2 (rr')
B'B'B'CCCCE'x^3 Cg C'r' C'b' C'g' Cr Cb	0	-2	0.5	G_2 (gg')
BBBC'C'C'C'Ex^3 Cg C'r' C'b' C'g' Cr Cb	0	2	-0.5	G_2 (gg')
B'B'B'CCCCE'x^3 C'g' C'r' Cb Cg Cr C'b'	0	-2	0.5	G_2 (bb')
BBBC'C'C'C'Ex^3 C'g' C'r' Cb Cg Cr C'b'	0	2	-0.5	G_2 (bb')
B'B'B'CCCCE'x^3 C'g' Cr C'b' C'g' Cr Cb	0	-2	0.5	G_2 (rg')
BBBC'C'C'C'Ex^3 C'g' Cr C'b' C'g' Cr Cb	0	2	-0.5	G_2 (rg')
B'B'B'CCCCE'x^3 C'g' Cr C'b' Cg Cr C'b'	0	-2	0.5	G_2 (rb')
BBBC'C'C'C'Ex^3 C'g' Cr C'b' Cg Cr C'b'	0	2	-0.5	G_2 (rb')
B'B'B'CCCCE'x^3 Cg C'r' C'b' Cg Cr C'b'	0	-2	0.5	G_2 (gb')
BBBC'C'C'C'Ex^3 Cg C'r' C'b' Cg Cr C'b'	0	2	-0.5	G_2 (gb')
B'B'B'CCCCE'x^3 Cg C'r' Cb Cg C'r' C'b'	0	-2	0.5	G_2 (r'g)
BBBC'C'C'C'Ex^3 Cg C'r' Cb Cg C'r' C'b'	0	2	-0.5	G_2 (r'g)
B'B'B'CCCCE'x^3 Cg C'r' Cb C'g' C'r' Cb	0	-2	0.5	G_2 (r'b)
BBBC'C'C'C'Ex^3 Cg C'r' Cb C'g' C'r' Cb	0	2	-0.5	G_2 (r'b)
B'B'B'CCCCE'x^3 C'g' Cr Cb C'g' C'r' Cb	0	-2	0.5	G_2 (g'b)
BBBC'C'C'C'Ex^3 C'g' Cr Cb C'g' C'r' Cb	0	2	-0.5	G_2 (g'b)

[1] The gluon has two alternative methods of construction. For the alternative method, replace B'B'CCx^5 by AE'x^6 in the LH spin forms and replace BBC'C'x^5 by A'Ex^6 in the RH spin forms.

[2] The higgs has two alternative methods of construction. For the alternative method, replace ABC'C'x^6 by B'Ex^7 in the LH spin forms and replace A'B'CCx^6 by BE'x^7 in the RH spin forms.

[3] The G graviton has two alternative methods of construction. For the alternative method, replace B'B'CCAB'x^4 by AAB'E'x^5 in the LH spin forms and replace BBC'C'A'Bx^4 by A'A'BEx^5 in the RH spin forms.

where x^n = any n pairs of preons from AA' or BB' or CC' or EE'.

Table 11: Twenty preons (tau and tau neutrino)

Preons	Electric charge	Spin	Weak isospin	Particle name
ACx^9	-1	-0.5	-0.5	LH tau-
BCx^9	-1	0.5	0	RH tau-
$B'Cx^9$	0	-0.5	0	LH tau sterile antineutrino
$BC'x^9$	0	0.5	0	RH tau sterile neutrino
$C'Ex^9$	0	0.5	-0.5	RH tau antineutrino
$CE'x^9$	0	-0.5	0.5	LH tau neutrino
$B'C'x^9$	1	-0.5	0	LH tau+
$A'C'x^9$	1	0.5	0.5	RH tau+
non-Standard Model				
x^{10}	0	0	0	neutral (dark) boson *
$ABC'C'$ x^8 or $B'Ex^9$	0	0	-0.5	Higgs-like particle (5/4 higgs) *
$A'B'CC$ x^8 or $BE'x^9$	0	0	+0.5	Higgs-like particle (5/4 higgs) *

where x^n = any n pairs of preons from AA' or BB' or CC' or EE'.

** These particles, in this generation, will have colour-anticolour forms.*

Table 12: Three hexacolour sub-preons plus three preons (up quark and down quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B’ C C C’r’ Cg Cb	-2/3	-0.5	0	r'	LH antiup
B’ C C Cr C’g’ Cb	-2/3	-0.5	0	g'	LH antiup
B’ C C Cr Cg C’b’	-2/3	-0.5	0	b'	LH antiup
E C’r’ Cg Cb x^1	-2/3	0.5	-0.5	r'	RH antiup
E Cr C’g’ Cb x^1	-2/3	0.5	-0.5	g'	RH antiup
E Cr Cg C’b’ x^1	-2/3	0.5	-0.5	b'	RH antiup
A C'g' Cr C'b' x^1	-1/3	-0.5	-0.5	r	LH down
A Cg C'r' C'b' x^1	-1/3	-0.5	-0.5	g	LH down
A C'g' C'r' Cb x^1	-1/3	-0.5	-0.5	b	LH down
B C'g' Cr C'b' x^1	-1/3	0.5	0	r	RH down
B Cg C'r' C'b' x^1	-1/3	0.5	0	g	RH down
B C'g' C'r' Cb x^1	-1/3	0.5	0	b	RH down
B' Cg Cb C'r' x^1	1/3	-0.5	0	r'	LH antidown
B' C'g' Cb Cr x^1	1/3	-0.5	0	g'	LH antidown
B' Cg C'b' Cr x^1	1/3	-0.5	0	b'	LH antidown
A' Cg Cb C'r' x^1	1/3	0.5	0.5	r'	RH antidown
A' C'g' Cb Cr x^1	1/3	0.5	0.5	g'	RH antidown
A’ Cg Cr C'b' x^1	1/3	0.5	0.5	b'	RH antidown
E’ Cr C’g’ C’b’ x^1	2/3	-0.5	0.5	r	LH up
E’ C’r’ Cg C’b’ x^1	2/3	-0.5	0.5	g	LH up
E’ C’r’ C’g’ Cb x^1	2/3	-0.5	0.5	b	LH up
B C’ C’ Cr C’g’ C’b’	2/3	0.5	0	r	RH up
B C’ C’ C’r’ Cg C’b’	2/3	0.5	0	g	RH up
B C’ C’ C’r’ C’g’ Cb	2/3	0.5	0	b	RH up

where x^1 = any one pair of preons from AA’ or BB’ or CC’ or EE’.

Table 13: Three hexacolour sub-preons plus eleven preons (charm quark and strange quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B’ C C C’r’ Cg Cb X^4	-2/3	-0.5	0	r'	LH anticharm
B’ C C Cr C’g’ Cb X^4	-2/3	-0.5	0	g'	LH anticharm
B’ C C Cr Cg C’b’ X^4	-2/3	-0.5	0	b'	LH anticharm
E C’r’ Cg Cb X^5	-2/3	0.5	-0.5	r'	RH anticharm
E Cr C’g’ Cb X^5	-2/3	0.5	-0.5	g'	RH anticharm
E Cr Cg C’b’ X^5	-2/3	0.5	-0.5	b'	RH anticharm
A C'g' Cr C'b' X^5	-1/3	-0.5	-0.5	r	LH strange
A Cg C'r' C'b' X^5	-1/3	-0.5	-0.5	g	LH strange
A C'g' C'r' Cb X^5	-1/3	-0.5	-0.5	b	LH strange
B C'g' Cr C'b' X^5	-1/3	0.5	0	r	RH strange
B Cg C'r' C'b' X^5	-1/3	0.5	0	g	RH strange
B C'g' C'r' Cb X^5	-1/3	0.5	0	b	RH strange
B' Cg Cb C'r' X^5	1/3	-0.5	0	r'	LH antistrange
B' C'g' Cb Cr X^5	1/3	-0.5	0	g'	LH antistrange
B' Cg C'b' Cr X^5	1/3	-0.5	0	b'	LH antistrange
A' Cg Cb C'r' X^5	1/3	0.5	0.5	r'	RH antistrange
A' C'g' Cb Cr X^5	1/3	0.5	0.5	g'	RH antistrange
A' Cg C'b' Cr X^5	1/3	0.5	0.5	b'	RH antistrange
E’ Cr C’g’ C’b’ X^5	2/3	-0.5	0.5	r	LH charm
E’ C’r’ Cg C’b’ X^5	2/3	-0.5	0.5	g	LH charm
E’ C’r’ C’g’ Cb X^5	2/3	-0.5	0.5	b	LH charm
B C’ C’ Cr C’g’ C’b’ x^4	2/3	0.5	0	r	RH charm
B C’ C’ C’r’ Cg C’b’ x^4	2/3	0.5	0	g	RH charm
B C’ C’ C’r’ C’g’ Cb x^4	2/3	0.5	0	b	RH charm

where x^n = any n pairs of preons from AA’ or BB’ or CC’ or EE’.

Table 14: Three hexacolour sub-preons plus nineteen preons (top quark and bottom quark)

Preons and sub-preons	Electric charge	Spin	Weak isospin	Particle Colour	Particle name
B’ C C C’r’ Cg Cb x^8	-2/3	-0.5	0	r'	LH antitop
B’ C C Cr C’g’ Cb x^8	-2/3	-0.5	0	g'	LH antitop
B’ C C Cr Cg C’b’ x^8	-2/3	-0.5	0	b'	LH antitop
E C’r’ Cg Cb X^9	-2/3	0.5	-0.5	r'	RH antitop
E Cr C’g’ Cb X^9	-2/3	0.5	-0.5	g'	RH antitop
E Cr Cg C’b’ X^9	-2/3	0.5	-0.5	b'	RH antitop
A C'g' Cr C'b' X^9	-1/3	-0.5	-0.5	r	LH bottom
A Cg C'r' C'b' X^9	-1/3	-0.5	-0.5	g	LH bottom
A C'g' C'r' Cb X^9	-1/3	-0.5	-0.5	b	LH bottom
B C'g' Cr C'b' X^9	-1/3	0.5	0	r	RH bottom
B Cg C'r' C'b' X^9	-1/3	0.5	0	g	RH bottom
B C'g' C'r' Cb X^9	-1/3	0.5	0	b	RH bottom
B' Cg Cb C'r' X^9	1/3	-0.5	0	r'	LH antibottom
B' C'g' Cb Cr X^9	1/3	-0.5	0	g'	LH antibottom
B' Cg C'b' Cr X^9	1/3	-0.5	0	b'	LH antibottom
A' Cg Cb C'r' X^9	1/3	0.5	0.5	r'	RH antibottom
A' C'g' Cb Cr X^9	1/3	0.5	0.5	g'	RH antibottom
A' Cg C'b' Cr X^9	1/3	0.5	0.5	b'	RH antibottom
E’ Cr C’g’ C’b’ X^9	2/3	-0.5	0.5	r	LH top
E’ C’r’ Cg C’b’ X^9	2/3	-0.5	0.5	g	LH top
E’ C’r’ C’g’ Cb X^9	2/3	-0.5	0.5	b	LH top
B C’ C’ Cr C’g’ C’b’ x^8	2/3	0.5	0	r	RH top
B C’ C’ C’r’ Cg C’b’ x^8	2/3	0.5	0	g	RH top
B C’ C’ C’r’ C’g’ Cb x^8	2/3	0.5	0	b	RH top

where x^n = any n pairs of preons from AA’ or BB’ or CC’ or EE’.

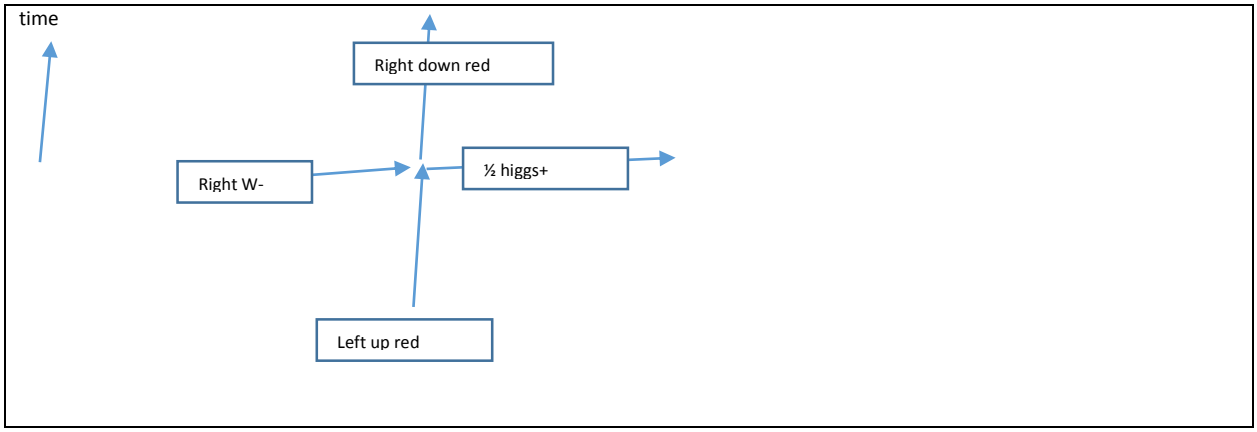
Some implications of the hexark and preon model #7

The implications of preon model #7 for the graviton, dark matter and dark energy were recently covered in Fearnley (October 2015). The implications for other matters were covered in the earlier Model #6 (Fearnley, May 2015) but as the structure of the left-hand up quark and neutrino were not explained enough in the October paper and as the preon structure of these two particles has been amended, some illustration of these two particles is given below.

Left-handed up quark

Figure A shows an interaction in which a left-handed red up quark is converted by a W- boson into a right-handed red down quark. A ½ higgs boson is emitted together with the down quark. The interaction is also explained in an interaction path where the individual preons are conserved in the interaction.

Figure A The conversion of a LH red up quark to a RH red down quark



The conversion of a LH red up quark to a RH red down quark can be shown as:

LH red up + RH W- -> RH red down + ½ higgs+

(2/3, -0.5, 0.5, red) + (-1, 1, 0) -> (-1/3, 0.5, 0, red) + (0, 0, 0.5)

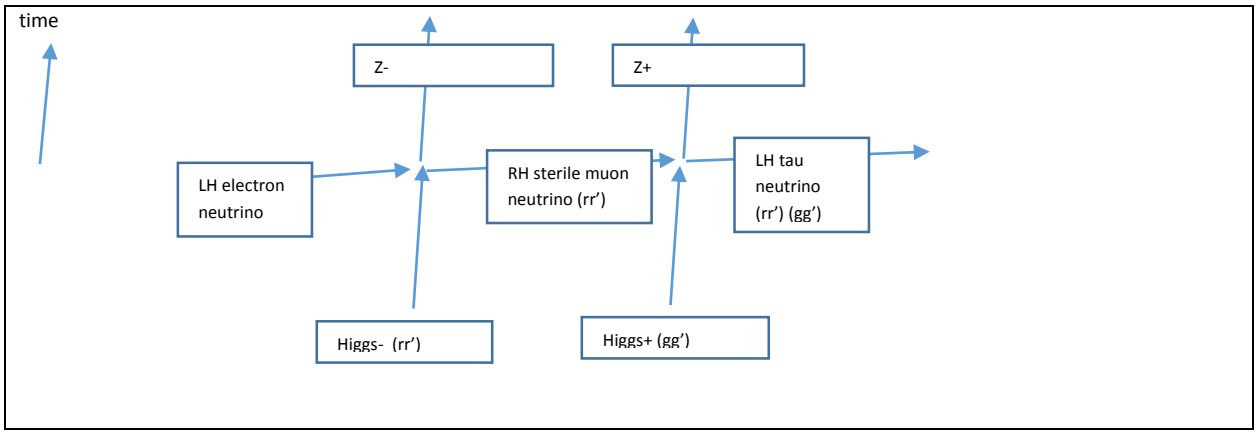
E’ Cr C’g’ C’b’ x^1 + BBx^3 -> B C'g' Cr C'b' x^1 + BE’x^3

Parentheses are: (electric charge, spin, weak isospin, colour).

The neutrino

In Figure B is an example of neutrino oscillation interactions which convert electron neutrinos into higher generation neutrinos. These interactions require the existence of sterile neutrinos.

Figure B Conversion of an electron neutrino to a tau neutrino



Higgs- + LH electron neutrino -> RH sterile muon neutrino + Z-

(0, 0, -0.5, rr') + (0, -0.5, 0.5) -> (0, 0.5, 0, rr') + (0, -1, 0)

16 preons + 4 preons -> 12 preons + 8 preons

ABC'C' Cr C'g' C'b' C'r' Cg Cb x^5 + CE'x^1 -> BC' Cr C'g' C'b' C'r' Cg Cbx^4 + AE' x^3

Followed by:

Higgs+ + RH sterile muon neutrino -> LH tau neutrino + Z+

(0, 0, 0.5, gg') + (0, 0.5, 0, rr') -> (0, -0.5, 0.5, rr'gg') + (0, 1, 0)

16 preons + 12 preons -> 20 preons + 8 preons

A'B'CC C'r'CgC'b' CrC'g'Cb x^5 + BC' CrC'g'C'b' C'r'CgCb x^4

-> CE' C'r'CgC'b' CrC'g'Cb CrC'g'C'b' C'r'CgCb x^7 + A'E x^3

Although these particles look heavily loaded with colour, the structure of

C'r'CgC'b' CrC'g'Cb can be re-written as CC';

CrC'g'C'b' C'r'CgCb can be re-written as CC'; and

C'r'CgC'b' CrC'g'Cb CrC'g'C'b' C'r'CgCb can be re-written as CCC'C'

And the interaction could therefore be written more simply as:

ABC'C' CC' x5 + CE'x1 -> BC'CC'x4 + AE' x3

Followed by

A'B'CC CC'x5 + BC' CC'x4 -> CE' CC'CC'x7 + A'E x3

The form of the tau neutrino has been shown here as having colour rr'gg'. This colour structure is tentative at present but can easily be replaced by the colourless version of the path interaction shown immediately above, in line with the properties of the tau neutrino in Table 11.

Next model for preons and hexarks

Model #7 will need to be modified to accommodate the production of fractional electric charges at or near absolute zero temperature in the Fractional Quantum Hall Effect (Pan et al, 2003). This change could involve having many more hexarks in a preon than 24. Also, preons A, B and E may also need to be sub-divisible similar to the way in which Preon C has been sub-divided into three sub-preons.

The preon contents in Model #7 appear to be an improvement on those in Model #6 as they are now all 'half' of a first generation elementary particle. The hexarks are thought to be more durable forms than the preons as they form a complete set of entities. If one hexark was missing from a table, its absence would be immediately noticeable, which is not true for the preons. It is possible that the preons interact via a colour force: this would require refining the preon to have colour charge or even colour-anticolour charges and perhaps could have fractional colour properties.

A future model might reduce the all-or-nothing nature of the hexarks. Each hexark is wholly committed to every characteristic totally one way or the other. For example hexark L - - - r is wholly red, wholly of spin '-' and wholly of weak isopin '-'. Since the hexarks are considered to be string-like, with lots of content, they should probably be a mix of all properties but with a net excess of red and a net excess of minus spin, and so on. Likewise, Preon A is all-or-nothing (all negative properties) with respect to electric charge, spin and weak isospin. This should probably change in a future model so that Preon A instead has a net excess of these properties. This could help adapt the preon model to cater for the fractional charges in the fractional quantum hall effect and perhaps obtain fractional colour charges to cater for strong colour binding of preons within the elementary particles.

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APPENDIX

Tables of the hexarks contained in the four neutral-colour preons: A, B, C and E and in their 'antimatter' versions: A', B', C' and E'

Table A: Preon Unit A: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin -1/2; and total weak isospin -1/2;
total hexatone is - 1/2.

L - - - r	L - - - r	L - - - r	L - - - r
L - - - g	L - - - g	L - - - g	L - - - g
L - - - b	L - - - b	L - - - b	L - - - b
R' - - - r	R' - - - r	R' - - - r	R' - - - r
R' - - - g	R' - - - g	R' - - - g	R' - - - g
R' - - - b	R' - - - b	R' - - - b	R' - - - b

Table B: Preon Unit B: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin +1/2; and total weak isospin is zero;
total hexatone is -1/2.

L - + - r	L - + + r	L - + - r	L - + + r
L - + - g	L - + + g	L - + - g	L - + + g
L - + - b	L - + + b	L - + - b	L - + + b
R' - + - r	R' - + + r	R' - + - r	R' - + + r
R' - + - g	R' - + + g	R' - + - g	R' - + + g
R' - + - b	R' - + + b	R' - + - b	R' - + + b

Table C: Preon Unit C: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin is zero; and total weak isospin is zero;
total hexatone is -1/2.

L - - - r	L - - + r	L - + - r	L - + + r
L - - - g	L - - + g	L - + - g	L - + + g
L - - - b	L - - + b	L - + - b	L - + + b
R' - - - r	R' - - + r	R' - + - r	R' - + + r
R' - - - g	R' - - + g	R' - + - g	R' - + + g
R' - - - b	R' - - + b	R' - + - b	R' - + + b

Table E: Preon Unit E: 12 hexarks and 12 antihexarks
Total electric charge is -1/2; total spin is 1/2; and total weak isospin is -1/2; total hexatone is -1/2.

L - + - r	L - + - r	L - + - r	L - + - r
L - + - g	L - + - g	L - + - g	L - + - g
L - + - b	L - + - b	L - + - b	L - + - b
R’ - + - r	R’ - + - r	R’ - + - r	R’ - + - r
R’ - + - g	R’ - + - g	R’ - + - g	R’ - + - g
R’ - + - b	R’ - + - b	R’ - + - b	R’ - + - b

Table A’: Preon Unit A’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin +1/2; and total weak isospin +1/2; total hexatone is +1/2.

L’ + + + r’	L’ + + + r’	L’ + + + r’	L’ + + + r’
L’ + + + g’	L’ + + + g’	L’ + + + g’	L’ + + + g’
L’ + + +b’	L’ + + + b’	L’ + + + b’	L’ + + + b’
R + + + r’	R + + + r’	R + + + r’	R + + + r’
R + + + g’	R + + + g’	R + + + g’	R + + + g’
R + + + b’	R + + + b’	R + + + b’	R + + + b’

Table B’: Preon Unit B’: 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin -1/2; and total weak isospin is zero; Total hexatone is +1/2.

L’ + - - r’	L’ + - + r’	L’ + - - r’	L’ + - + r’
L’ + - - g’	L’ + - + g’	L’ + - - g’	L’ + - + g’
L’ + - - b’	L’ + - + b’	L’ + - - b’	L’ + - + b’
R + - - r’	R + - + r’	R + - - r’	R + - + r’
R + - - g’	R + - + g’	R + - - g’	R + - + g’
R + - - b’	R + - + b’	R + - - b’	R + - + b’

Table C': Preon Unit C': 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin is zero; and total weak isospin is zero; total hexatone is +1/2.

L' + - - r'	L' + - + r'	L' + + - r'	L' + + + r'
L' + - - g'	L' + - + g'	L' + + - g'	L' + + + g'
L' + - - b'	L' + - + b'	L' + + - b'	L' + + + b'

R + - - r'	R + - + r'	R + + - r'	R + + + r'
R + - - g'	R + - + g'	R + + - g'	R + + + g'
R + - - b'	R + - + b'	R + + - b'	R + + + b'

Table E': Preon Unit E': 12 hexarks and 12 antihexarks
Total electric charge is +1/2; total spin is -1/2; and total weak isospin is +1/2; total hexatone is +1/2.

L' + - + r'	L' + - + r'	L' + - + r'	L' + - + r'
L' + - + g'	L' + - + g'	L' + - + g'	L' + - + g'
L' + - + b'	L' + - + b'	L' + - + b'	L' + - + b'

R + - + r'	R + - + r'	R + - + r'	R + - + r'
R + - + g'	R + - + g'	R + - + g'	R + - + g'
R + - + b'	R + - + b'	R + - + b'	R + - + b'

Tables of the hexarks contained in the three colour sub-units: Cr, Cg and Cb and in their 'antimatter' versions: C'r', C'g' and C'b'

Table Cr: Preon Cr: 4 red hexarks and 4 red antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - r	L - - + r	L - + - r	L - + + r
R' - - - r	R' - - + r	R' - + - r	R' - + + r

Table Cg: Preon Cg: 4 green hexarks and 4 green antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - g	L - - + g	L - + - g	L - + + g
R' - - - g	R' - - + g	R' - + - g	R' - + + g

Table Cb: Preon Cb: 4 blue hexarks and 4 blue antihexarks
Total electric charge is -1/6; total spin is zero; and total weak isospin is zero; total hexatone is -1/6.

L - - - b	L - - + b	L - + - b	L - + + b
R’ - - - b	R’ - - + b	R’ - + - b	R’ - + + b

Table 3C’r’: Preon C’r’: 4 antired hexarks and 4 antired antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - r’	L’ + - + r’	L’ + + - r’	L’ + + + r’
R + - - r’	R + - + r’	R + + - r’	R + + + r’

Table C’g’: Preon C’g’: 4 antigreen hexarks and 4 antigreen antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - g’	L’ + - + g’	L’ + + - g’	L’ + + + g’
R + - - g’	R + - + g’	R + + - g’	R + + + g’

Table C’b’: Preon C’b’: 4 antiblue hexarks and 4 antiblue antihexarks
Total electric charge is +1/6; total spin is zero; and total weak isospin is zero; total hexatone is +1/6.

L’ + - - b’	L’ + - + b’	L’ + + - b’	L’ + + + b’
R + - - b’	R + - + b’	R + + - b’	R + + + b’

A hexark’s electric charge is + or - 1/48; A hexark’s spin is + or - 1/48; A hexark’s weak isospin is + or - 1/48. A hexark’s hexatone is also + or - 1/48: r, g and b each have hexatone = -1/48 and r’, g’ and b’ each have hexatone = +1/48.